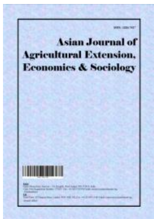

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Analysis of Profit Efficiency of Sesame Production in Yobe State, Nigeria: A Stochastic Translog Profit Function Approach

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Authors' contributions

This work was carried out in collaboration among all authors. Author SEG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BGS and ASSU managed the analyses and supervised the study. Author ET managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Sesame productions are constantly bedeviled with menace because of inadequate supply of quality seed, extension services, credit facilities, presence of inefficiencies among others. The capacity of sesame producers to accept new innovation and achieve sustained production relies upon the level of profit efficiency, generally dictated by variable input and output prices including the cost of fixed factors of production. Physical profitability contemplations such technical, allocative and economic efficiency are significant in improving production proficiency but profit efficiency will result to higher profit to sesame farmers. This paper examined the profit efficiency of sesame production in Yobe State, Nigeria.

Research Methods: Multistage sampling procedure is utilized to choose the farmers. A structured questionnaire is administered to 180 respondents spread across 12 Local Government Areas to acquired essential information. Descriptive statistics used includes mean, frequency and percentage. The inferential statistic used is stochastic translog profit function.

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Findings: The result of levels of profit efficiency shows the mean profit efficiency of 0.8828. The result of the translog profit function indicates the sigma square to be 0.249 and variance of 0.909. All the cost variables has negative coefficients and significant at one percent level except for cost of farmlands. The inefficiency variables levels of education, Access to Extension Services, Access to credits among others reduce inefficiency while off-farm income and access to market information increase inefficiency.

Conclusion: It can be concluded that inefficiency exist in the utilization of resources. All the input cost variable decreases profit efficiency and all the socioeconomic characteristics decreases profit inefficiency with the exception of, off-farm income and access to market information which were found to increase profit inefficiency.

Keywords: Profit efficiency; sesame production; stochastic translog profit efficiency; Yobe State; sesame farmers; coefficient.

1. INTRODUCTION

Sesame is an ancient oil seed crop since civilization. Sesame (*sesamum indicum L.)* is a significant plant in or among Nigerian farmers and it is widely grown solely or intercropped with other plants as a small-holder plant [1]. It flourishes well in moderately poor climatic conditions except waterlogging. It is fit to smallholder cultivating due of its general short reap pattern of 90 –140 days which permits different crops to be raised in a similar field [2].

Global production of sesame was estimated to be 5,531,948 tons produced on 9,983,165 hectares of land in 2017. Production shares among the main producers of sesame in the world are Asia (56.4%), Africa (39.3%) and America (4.4%). The largest producers of sesame is India (665,566.67 tonnes) followed by China (616,004.96 tonnes) and Nigeria (192,295.96 tonnes) ranks 8th out of the ten (10) major producing countries in the world [3].

Sesame is processed and used in various ways. Principal products are local snacks and pap. In addition, the oil extricated from the seed and cake can be used to produce "*kulikuli*" which along with the leaves are utilized to produce local soup known as "*miyar taushe*". The oil is utilized for cooking and has medicinal value, for example, the cure of ulcers and burns. The stem and the oil remove are similarly utilized in producing soap. The youthful leaves can be used in stews while the dried stems can serve as a source of fuel [2]. Industrially, most sesame is processed into meal, paste, confections, and bakery products. The oil can also serve as raw material for producing varnishes, margarine and paints. The seed of sesame consumed with sugar in various forms. The black til is also used in worship.

Major sesame growing states in Nigeria are Nasarawa, Jigawa, Benue, Yobe, Kano, Katsina, Kogi, Gombe and Plateau States (Nigeria Export Promotion Council [4]. The highest grower of sesame seeds in Africa is Nigeria but 90% of sesame seeds produced is sold outside the country. In the first quarter of 2018, it was the highest exported non-oil commodity. It contributed 0.57% of the total export value and 36.39% of the total agricultural exports to the Nigeria economy [5]. Nigeria has the highest untapped potential from sesame export estimated to be $170 million [6]. Attributed to its increasing demand, any amount of the product offered to the market is effortlessly sold. This increasing demand for sesame seed gives Nigeria the privilege to increase its production to satisfy the worldwide demand for the product. The realization of the capability of sesame production to earn foreign exchange for the country has made the production of sesame a prominent figure in the country.

Sesame is one of the cash crops grown in Yobe State. It's a very popular crop among the rural farmers. It's reported that 85% of small scale farmers in Yobe State are into sesame production, processing and marketing of sesame within the area which shows the usefulness of the crop to improve the standard of living of all the actors involved in producing, marketing and processing of sesame crop [7]. Notwithstanding the great local and international market value and for its seed and oil, the production system is usually characterized by the utilization of traditional method. Despite all attempts to increase sesame production in Yobe State, the rural farmer still produces only at a subsistence level, using traditional system of farming and low-yielding varieties. Extension services haven't been very effective because improved technologies of sesame production are available in research Institutes, but haven't successfully reached sesame farmers [8]. Profit efficiency is defined as the ability of a farm to achieve the highest possible profits given the prices and levels of fixed factors of that farm. Meanwhile, Profit inefficiency is defined as loss of profit from not operating on the frontier given farm specific prices and resource base [9]. Because of worldwide food emergency that Nigeria isn't excluded from, more emphasis is currently being put on local supplies of farm products. One of the methods of doing this is by ensuring the efficient utilization of farm inputs by farmers [10]. A more efficient utilization of farm inputs would eventually affect emphatically profit efficiency and by extension, farmers' profitability, *ceteris paribus*. In Nigeria and Sub-Saharan Africa, more than 90% of agricultural output are from these resource-poor smallholder farmers and hence the need to be helped them to rise above the level of subsistence to higher levels of productivity through effective utilization of farm inputs [11] and [12]. Nigeria's inability to completely take advantage of the economic potentials of the crop may be as a result of its inefficient nature in crop production [13]. One of the main factor behind low agricultural productivity in Nigeria is farmers' restricted access to farm inputs which are vital for attaining a higher level of profit efficiency [14,15] opined that crop farmers do most of their production activities under conditions involving the utilization of inefficient tools and inadequate improved seed varieties and consequently, maximum efficiency (TE, AE, EE and profit efficiency) is elusive to them.

The international price of sesame has been inclining because of the increasing demand for the product in most parts of the world. However, this increase in the price of the product is being upset by the ever rising cost of inputs in the nation which in return is reducing farmers' profit.

In a related development, [16] revealed that profit efficiency differs greatly among farmers, varying from 20.12% to 99.97%. This variation is attributed to differences in efficient allocation and utilization of inputs among the farmers. The mean profit efficiency was 56.75% meaning that yam farmers in the areas have the opportunity of increasing their profit by 43.25% by using the available production techniques utilized by the best farmer. [17] estimated a translog stochastic profit function for rice farmers in Bangladesh. The results showed that a high level of inefficiency existed in rice farming. The mean level of profit efficiency was 77% suggesting that an estimated 23% of the profit was lost due to inefficiency in modern rice production. Furthermore, [18] in a study titled "Profit Efficiency among Rain-Fed Rice Farmers in Northern Taraba State , Nigeria" reported that the profit efficiency ranged between 0.004 and 0.93 for the worst and best farmer respectively and with mean efficiency of 0.59. This implies that the average rice farmer in the study area could increase profit by 41% by improving his/her technical and allocative efficiencies. This suggests that there is a wide chance for the farmers to increase their farm incomes and consequently reduce their poverty level.

According to [19], the Inefficiency model revealed that farming experience, household size, access to credit, extension services, membership to farmers' group and market information access influenced profit inefficiency in rice production in the study area. [20] found out that education attainment, household farm labor, farm size, training, farmer's association membership had positive effect on profit efficiency while farming experience and distance from the main field to the key input market had negative effect on profit efficiency. [21] investigated factors that determine the profit efficiency among small scale rice farmers in Nigeria, the results showed that their profit efficiency were positively influenced by age, educational level, farming experience and household size. Furthermore, [22] examined the profit efficiency among cassava producers in Southwestern Nigeria, the result showed that household size and farm size were the major significant factors which influenced profit efficiency positively.

Despite all the effort made, limited attention has been paid to the investigation of the profit efficiency of sesame farmers in Yobe State. Most studies conducted on sesame in the recent past by [1,23,24,25,26,27] and [17] had been on production, technical and allocative efficiencies using traditional frontier function in the study area. A study on sesame profit efficiency that uses stochastic translog profit function aimed at discovering factors contributing to profit efficiency that could be exploited to aid farmers to improve/increase their profitability is inadequate. The specific objectives are to:

i. determine the level of profit efficiency of sesame producers; and
ii. examine the determinants of profit efficiency among sesame producers;

2. METHODOLOGY

2.1 Background to the Study Area

Yobe State is located between latitudes 10°25'55'' North to 11°34'25'' East and longitudes 11°19'50'' East to 13°25'13'' North of the equator. It has a total area of 45,502 km^2 and a projected population of 3,408,062 as at 2018 using an annual growth rate of 3.2% [28], with a population density of 74.9/km^2. It is made up of three [18] agricultural zones which include Zone I, Zone II and Zone III consisting of 17 Local Governments Areas. The State shares borders with Nigerian states such as Borno State to the south and east, Bauchi and Jigawa States to the west and Gombe state to the south. It also shares international boundary with Diffa Region and Zinder Region in the Republic of Niger to the north.

The State lies largely in the dry Savanna belt. Weather conditions are hot and dry for the greater part of the year, with exception in the southern part of the State which has a milder climatic condition. The hottest months are March, April and May with temperatures varying from 30°C – 42°C. The period of rainy season in the state differs here and there, but generally last for about 120 days in the north and more than 140 days in the south. The annual rainfall ranges from 400 mm – 500 mm in the North and 600 mm – 1000 m in the southern part of the state and the rainy season is normally from June to September in the north and May to October in the south. This is suitable for the growth and development of sesame requiring little water.

Yobe State is basically an agrarian state. The principal occupation of the people in the state is small scale farming with little resources. Major crops grown in the study area include sesame, rice, maize, sorghum, wheat, gum arabic, groundnuts, cowpea and cotton. Livestock kept includes sheep, cattle and goat. The major ethnic groups in the state are Fulani and Kanuri while other ethnic communities of the area include Ngizim, Karai-Karai, Bade, Bolewa, Shuwa, Ngamo, Hausa, Bura, Marghi and Manga [29].

As a small scale farmer, the crop supply chain is described by purchasers or agents who visit the provincial regions purchasing from the farmers. The sesame is shipped to the bigger towns, bulked in store and sold to the agents of the exporters. The main purchasing market is the urban market in Potiskum [2].

2.2 Sampling Procedure

Multistage sampling procedure was utilized in choosing the respondents for the study. Yobe State is partitioned into three agricultural zones namely; Zone I, Zone II and Zone III. All the three zones were used in the survey because sesame growing areas transverse throughout the zones. In the first stage, one Local Government Area from each of the three (3) zones was purposively selected which are known for sesame production and is accessible. The selected Local Government Areas are Potiskum (Zone I), Jakusko (Zone II) and Tarmuwa (Zone III). The second stage involved the purposive selection of four major sesame producing communities in each of the three Local Government area selected based on the intensity of sesame farming practiced in the areas. The list of sesame farming villages was obtained from Yobe State Agricultural development Programme (YOSADP) office. Twelve communities with the highest number of sesame farmers selected were across the three Local Government Areas. The third stage involved estimation of sample size from the sample frame using [30] (equation 1). Lastly, the number of respondents in each communities were selected using [31] (equation 2) as shown in Table 1. The sampling frame is the list of sesame farmers in the selected communities which was obtained from YOSADP.

Following [30] equation for sample size determination procedure, the ideal sample size was determined dependent on a population of 1501 from the sampling frame as outline in Table 1 using a precision level of 7%.

2.3 Sampling Size

$$s = \frac{S}{1 + Se^2} \ldots\ldots \qquad (1)$$

Therefore, sampling size (s) = $\frac{1501}{1 + 1501 * 0.07^2}$

$$s = \frac{1501}{8.3549} = 180$$

Where

s = Sampling size
S = Population size
e = level of precision (acceptable sample error).

Using [31], the number of respondent in each community was obtained with the help of the formula below as shown in Table 1.

$$\mathrm{NI} = \frac{n}{N} \times \mathrm{Ni} \quad (2)$$

Where

NI = sample size in each village
n = actual sample size, that is 180
N = actual number of farmers in the targeted population, that is total sample frame (1501)
Ni = actual number of farmers in each village

2.4 Sources of Data

The data were gotten from both primary and secondary sources. Primary data were gathered through the utilization of structured questionnaire distributed to sesame farmers by the enumerators in the study area. Secondary information was obtained from record of registered sesame farmers, journals, textbooks, relevance publications, Government gazettes, internet and other sources.

2.5 Analytical Techniques

The data collected was subjected to descriptive and inferential statistics. The inferential statistics was Translog profit function which was used to achieve the objective of the study.

2.6 Stochastic Frontier Translog Profit Function

The Stochastic profit Function with both technical and allocative inefficiencies is implicitly expressed mathematically as following [32,33]:

$$\pi_i = f(P_{ij}, Z_{ik}) \exp(\varepsilon_j) \quad (3)$$

Where: π_i = normalised profit of the i^{th} farm and is calculated as gross revenue less variable cost divided by farm-specific output prices; P_{ij} = the price of j^{th} variable input faced by the i^{th} farm divided by output price; Z_{ik} = degree of k^{th} fixed factor on the i^{th} farm; ε_i = the error term; i = 1, 2, ………………n, number of farm in the sample; j = 1, 2,…………m, number of variable inputs used.

The error term is assumed to behave in a way similar with the frontier concept [9]:

$$\varepsilon_j = V_i - U_i \quad (4)$$

Where;

V_i is assumed to be independently and identically distributed N (0, δ^2_v), two sided random error independent of the U_i. U_is are non-negative random variables associated with inefficiency in production which are assumed to be independently distributed as truncations at zero of the normal distribution with mean; The firm-specific inefficiency effects are obtained by referring to the distribution of the U_i term in Equation 5, which are non-negative random variables assumed to be identically and independently distributed such that U_i is defined by truncation at zero of the standard distribution with a mean:

$$U_i = \delta_o + \sum_{d=1}^{10} \delta_d w_{di} \quad (5)$$

And variance σ^2_u (|N(U, σ^2_u)|)

Table 1. Sample distribution

Senatorial Districs	LGA	Communities	Sample Frame	NI= $\frac{n}{N} \times \mathrm{Ni}$	Sample Size
Yobe North	Jakusko	Jakusko	159	(180/1501) ×159	19
		Buduwa	179	(180/1501) ×179	21
		Girgir	89	(180/1501) ×89	11
		Amshi	121	(180/1501) ×121	15
Yobe East	Tarmuwa	Babangida	146	(180/1501) ×146	18
		Lantaiwa	99	(180/1501) ×99	12
		Biriri	110	(180/1501) ×110	13
		Koriyel	97	(180/1501) ×97	12
Yobe South	Potiskum	Alaraba	94	(180/1501) ×94	11
		Badejo	103	(180/1501) ×103	12
		Mazagane	133	(180/1501) ×133	16
		Potiskum	171	(180/1501) ×171	20
Total			1501		180

Source: Field Survey, 2019

Where:

> Wd = d^{th} explanatory variable associated with inefficiency on farm i. δ0 and δd are unknown parameters to be evaluated.
> Individual efficiency score is set as: $Eff_i = E(\exp(U_i)/e_i) = E(\exp(-\delta_0 - \Sigma\delta_d/e_j)$
> Eff_i = the efficiency of firm i relative to the best performing firm.

2.7 The Empirical Model

This study estimates a flexible translog profit function which is express as:

$$ln\pi' = \propto_0 + \sum_{i=1}^{3} \propto_i lnp_i + \frac{1}{2}\sum_{i=1}^{3}\sum_{k=1}^{3} \tau_{ik} \ln P_i \, lnP_k + \sum_{i=1}^{3}\sum_{l=1}^{2} \emptyset_{il} \, lnP_i \, lnZ_l + \sum_{i=1}^{2} \beta_l \, lnZ_l + \frac{1}{2}\sum_{i=1}^{2}\sum_{q=1}^{2} \emptyset_{lq} \, lnZ_l lnZ_q + V_i - U_i \quad (6)$$

Where: π' = restricted normalized profit calculated for the farm defined as gross revenue less variable costs divided by farm specific sesame price (p_j) (₦); p_{i} (p_j) = Cost of variable inputs (i, k =1, 2, and 3) normalised by price of output (₦); P_1 = The cost of hired labour normalised by output price of sesame (p_j) (₦); P_2 = The cost of seed normalised by output price of sesame (p_j) (Naira per kg of seed); P_3 = The cost of fertilizer normalised by the output price of sesame (p_j) (Naira per bag); P_4 = The cost of herbicides normalised by the output price of sesame (p_j) (Naira per litre); Zı = The quantity of fixed input (ı = 1, 2); Z_1 = Land under sesame (hectares under sesame) in farm j (ha); Z_2 = Depreciation on capital equipment used in the farm j (₦); V_i = Two sided random error; U_i = One sided half normal error; In = Natural logarithm

2.8 Inefficiency Model

$$U_i = \delta_o + \sum_{d=1}^{10} \delta_d w_{di} + \omega_i \quad (7)$$

Where: w_d = Variables explaining inefficiency effects, defined as follows: w_1 = Education (Years of education); w_2= extension services (Number of meeting in a season) ; w_3 = Access to credit (yes = 1, No = 0); w_4 = Experience (years of experience in sesame production); w_5 = Off-farm income (Off-farm income = 1, No off-farm income = 0); w_6 = Variety (Improved = 1, Local = 0); w_7 = Group membership or cooperative (yes = 1, No = 0); w_8 = Market information access (yes = 1, No = 0); w_9 = Household size (Number of persons); w_{10} = Nearness to market (Number of kilometres away); ω = two sided random error; α_0, α_i, r_{ik}, $ø_{il}$,β_l, ϕ_{lq}, $\emptyset_{il}$, δ_d, and δ_0 are parameters to be estimated.

3. RESULTS AND DISCUSSION

3.1 Levels of Profit Efficiency in Sesame Production

The distribution of levels profit efficiency of sesame producers is presented in Table 1. The mean, maximum and minimum levels of profit efficiencies obtained from the study were 0.8823, 1.000 and 0.0201 respectively. This indicates that there is ample opportunity for improvement on the level of profit efficiency among sesame farmers in the study area. This infers that sesame farmers can improve their profit efficiency by 11.77% utilizing the same inputs. In other words, potential existed for sesame farmers to increase current profits by 11.77% without adjustment in current input mix and production techniques. This infers that huge amount of sesame in the study area were not produced due to profit inefficiency in resource use among the sesame farmers. The farmers can increase their profits by about 11.77%, on average, to strengthen their competitiveness in the short run through the adoption of best farm practices that reduce inefficiencies to attain the profit frontier.

The least profit efficient farmer requires an efficiency gain of 79.9% [i.e. (1.00 – (0.0201/1.00)) x 100) in the utilization of specified farm resources if such a farmer was to attained the profit efficiency of the most effective farmer in study area. Similarly, an average efficient farmer would require an efficiency gain of 11.77% (i.e. (1.00 – (0.8823 /1.00)) x 100) to reach the level of the most profit efficient sesame farmer. The efficiency results show that individual differences in profit efficiency levels at farms partly contributed to differences in their total sesame profits. This result conformed to the finding of

Table 2. Distribution of level of profit efficiency scores among sesame farmers in the study area

Efficiency Level	Frequency	Percentage
<0.200	3	1.67
0.20 - 0.30	6	3.33
0.31-0.40	7	3.89
0.41-0.50	12	6.67
0.51-0.60	19	10.56
0.61-0.70	23	12.77
0.71-0.80	28	15.56
0.81-0.90	60	33.33
0.91-1.0	22	12.22
Total	180	100.0
Mean	0.8823	
Min	0.0201	
Max	1.0000	

Source: Field Survey, 2019

[32] who announced a mean profit efficiency levels of 0.77 for Bangladeshi rice farmers and furthermore, [34] found a mean profit efficiency level of 77.75% for small scale cowpea farmers in Nigeria. On a general note, the result showed that almost all the farmers exhibited high (usually over 0.5) profit efficiency.

Further analysis revealed that13.89% of sesame farmers had profit efficiency level of 0.20 – 0.50 which was far away from the profit frontier and also from the mean. This means that sesame farmers were producing at a low level of profit efficiency and also had low profit. Similarly, 38.89% of sesame farmers had profit efficiency level of 0.51 – 0.80 which was near the profit frontier and also the mean. This infers that the sesame farmers within the study area were producing at high level of profit efficiency. Despite the variation in efficiency, Table 1 showed that 45.55% of the farmers seems to be skewed towards the mean and above and also the closest to the profit frontier with profit efficiency level of 0.81 – 1.00. This means that sesame farmers in this group were producing at a higher level of profit efficiency as well as profit than any other farmer in the study area. It had been discovered that even the most efficient sesame farmer didn't attained the optimal resource allocation and required improvements to attain the frontier profit. This improvement can be attained if the determinants of inefficiency are reduced

3.2 Determinants of Profit Efficiency of Sesame Production

The results of Maximum Likelihood estimates of the translog profit frontier function is presented in Table 3. The computed coefficient of sigma-squared was 0.249 and significant (P<0.01). This shows a good fit and correctness of the specified distributional form assumed for the composite error term. The value of gamma (γ) which represents the ratio of the variance of the farm specific profit efficiency to the total variance of profit was 0.909 and is significant (P<0.01) implying that 90.9% of the variation in profit was due to inefficiency.

The coefficient of cost of hired labour (-0.985) was negative and significant at 1% (P<0.01). This suggests that 1% increase in the cost of hired labour would result to decrease in profit efficiency by 0.985%. This will be owing to high cost of labour in the area. The finding is in line with that of [35] who reported that the coefficient of hired labour was negative (-0.0072) and significance at 1% level (P<0.01).

The assessed coefficient for cost of seed (-0.556) was negative and significant (P<0.01) implying that 1% increase in the cost of seed would result to a decrease in the profit efficiency by 0.556% obtained from sesame production. This result is in tandem with [19] and [16] who revealed a negative relationship between profit efficiency and cost of seed.

The estimated coefficient for fertilizer cost (-3.968) was negative and significant (P<0.01). This implied that 1% increase in the cost of fertilizer would result to a decrease in the profit efficiency by 3.968% obtained from sesame production. This result is in tandem with the finding by [32,21,36] and [20].

Table 3. Determinants of profit efficiency among sesame farmers

Variables	Parameter	Coefficient	t-ratio
Constant	p_0	-1.218	-6.743***
Ln Cost of hired labour	p_1	-0.985	-4.376***
Ln Cost of seed	p_2	-0.556	-5.189***
Ln Cost of fertilizer	p_3	-3.968	-2.871***
Ln cost of Herbicides	p_4	-2.432	-2.754***
In cost of Farm Land	Z_1	-0.340	-1.941NS
In cost of Capital	Z_2	-0.297	-3.274***
½ In Cost of hired labour x In Cost of hired labour	γ_1	-13.968	-2.812***
½In cost of seed x In Cost of seed	γ_2	-26.432	-32.738***
½ In cost of herbicides x In cost of Herbicides	γ_3	-0.772	-2.966***
½ cost of fertilizer x In Cost of fertilizer	γ_4	-3.464	-3.922***
½ In Cost of Land x In Cost of land	γ_5	-0.985	-6.069***
½ In Cost of Capital x In of Capital	γ_6	-0.485	-1.563NS
In Cost of hired labour x In Cost of seed	γ_7	-2.825	-9.881***
In Cost of hired labour x In Cost of fertilizer	γ_8	-0.637	-1.984**
In Cost of hired labour x In cost of Herbicides	γ_9	-0.985	-6.069***
In Cost of fertilizer x In Cost of seed	γ_{10}	-0.245	-2.150**
In Cost of fertilizer x In cost of Herbicides	γ_{11}	-1.579	-2.324**
In Cost of hired labour x In Cost of land	γ_{12}	-1.189	-4.798***
In Cost of hired labour x In cost of Capital	γ_{13}	-1.874	-2.963***
In Cost of seed x In Cost of land	γ_{14}	-0.245	-2.189**
In Cost of seed x In cost of Capital	γ_{15}	-2.162	-3.934***
In Cost of fertilizer x In cost of land	γ_{16}	-0.950	-8.612***
In Cost of fertilizer x In cost of Capital	γ_{17}	-1.045	-6.598***
In cost of herbicide x In Cost of land	γ_{18}	-1.099	-5.456***
Ln cost of Herbicides x In cost of Capital	γ_{19}	-0.556	-5.193***
In cost of Land x In cost of Capital	γ_{20}	0.645	2.596***
Sigma squared		0.249	12.455***
Gamma		0.909	71.015***
Loglikelihood		143.5	
Inefficiency			
Constant	ω_0	-0.243	-2.354**
Education	ω_1	-0.245	-2.156**
Access to extension services (Dummy)	ω_2	-0.485	-1.976**
Access to credit (Dummy)	ω_3	-1.874	-2.943***
Farming experience	ω_4	-0.189	-3.519***
Off-farm income (Dummy	ω_5	0.131	3.724***
Variety of seed planted (Dummy)	ω_6	-0.791	-1.986**
Membership of Association	ω_7	-0.189	-4.732***
Access to market information (Dummy)	ω_8	0.579	2.321**
Household size	ω_9	-0.950	-8.665***
Nearness to market	ω_{10}	-2.162	-3.957***

Source: Field Survey, 2019.

*Note; ***, ** and NS are statistically significant at 1% and 5% and non-significant respectively*

The coefficient for cost of herbicide (-2.432) was negative and significant (P<0.01). This infers that 1% increase in the prices of chemical will cause a reduction in profit efficiency of sesame farmers by 2.432%. The negative sign may be traced to underutilization and overutilization of chemicals in the study area. This finding is in line with [32,37,38,16,22 and 39].

The coefficient of farm land (-0.340) was negative and non-significance (P>0.05). The negative coefficient infers that 1% increase in the cost of farm land could decrease profit efficiency by 0.340%. This may be due to over/under utilization of farmland resulting to additional cost incurred in the process of trying to boost the fertility of the soil; hence increasing their acreage will decrease profit efficiency, *ceteris paribus*. The non-significance of the cost of farm could be due the actual fact that most of the farmers inherited their land. [33 and 40] discovered that an expansion of the acreage cultivated under rice can result to attaining higher output and increase profit.

Similarly, the coefficient of capital (-0.297) was discovered to be negative and significant (P<0.01). This infers that 1% increase in farm capital would reduce profit efficiency by 0.297%. This might be attributed to improper use of capital resources. This finding is in line with that of [16,32 and 41] who reported a negative relationship between profit efficiency and stock of farm capital.

The Maximum Likelihood Estimate (MLE) of profit inefficiency among sesame farmers in Yobe State is also presented in Table 2. The sign of the variables in the inefficiency model is significant in clarifying the observed level of profit efficiency of the sesame producer. A negative sign on the coefficient suggests that the variable had an impact in decreasing profit inefficiency and a positive coefficient implies that the variable had an impact of increasing inefficiency [42].

Based on the findings of the inefficiency model, the evaluated coefficient of education (-0.245) is negative and significant (P<0.05) implying that education plays a crucial role in impacting the profit efficiency of sesame farmers. This infers that a higher level of education minimizes/reduces profit inefficiency, which is in consonant with the findings of [43,9,44 and 45] who revealed that farming experience was negatively associated with profit inefficiency.

The coefficient of Extension service (-0.485) was negative and significant (P<0.05). This infers that increase in extension services reduced profit inefficiency. This result is consistent with [46] and [47], which affirms that extension service offers technical support, including practice on right input utilization, market information accessibility and training on innovation technology which decrease profit inefficiency.

The result further revealed that the coefficient of access to credit (-1.874) was negative and statistically significant (P<0.001). This mean that access to credit reduced profit inefficiency. This finding is in consonant with the finding of [33,18,48,38] and [49] who reported a negative relationship between access to credit and profit inefficiency.

The estimated coefficient of farming experience (-0.189) was negative and significant (P<0.001). The result implies that increase farming experience reduced profit inefficiency. The result is in line with [50,51,32,41,52] and [38]. They found a negative and significant relationship between profit inefficiency and farming experience.

Off- farm income was positive (0.131) and statistically significant (P<0.01). This means that increase in off-farm income increases profit inefficiency. This is because farmers' time would be allocated among chain of economic activities they engage in, thus contributing to inefficiency in sesame production. This implies that availability of off-farm income explains the tendency of sesame farmers devoting extra resources sought from secondary occupation into sesame production. This could be in terms of procurement of contemporary productive inputs. [32,41] and [51] reported similar results that there exist a positive relationship between Off-farm Income and Profit inefficiency.

The coefficient of variety variable (-0.791) indicated a negative relationship and is significant (P<0.05). This infers that the employment of improve variety decrease profit inefficiency. Farmers who embraced improved (high yield) variety compared to local variety will normally be more profit efficiency and incur less profit-loss. This suggests that the utilization of improved variety in farming will increase profit efficiency. This result is in agreement with that of [42] and [19] who reported a negative relationship between variety and profit inefficiency. [18] additionally revealed that utilizing improved seed, which are more costly than local variety seed, increased farm profits of rain-fed rice farmers in Nigeria.

The coefficient of membership Association (-0.189) was negative and significant (P<0.01). This means that inefficiencies among sesame farmers may well be reduced if farmers are members of an association. The finding is in consonance with [53,19]. They reported a negative relationship between group membership and profit inefficiency.

The coefficient of access to market information (0.579) was positive and significant (P<0.05). This infers that increase access to market information increase inefficiency. This could be due to the simple reason that the farmers may not have gotten the information on time or they didn't make use of the information appropriately. Access to market information (input markets) will generally assist farmers to buy input at the right quantity, time, and cost. The finding is contrary with [49,36] and [19]. They reported a negative relationship between access to market information and profit inefficiency.

The assessed coefficient of household size (-0.950) was negative and significant (p<0.01). This shows that profit inefficiency decreases with increase in the size of households. The result collaborates with [52,51,45] and [53] who reported that huge household size decrease profit inefficiency.

The coefficient of distance to the market (-2.162) was negative and significant (P<0.01). This infers that the closer the market is located to the point of sesame production, the lower the profit inefficiency. This is predominantly a direct result of high transportation cost and less access to marketing and production innovation for those who reside in the rural areas. This finding agrees with [54,55,51] who reported similar finding.

4. CONCLUSION AND RECOMMENDATIONS

It can be concluded that sesame farmers are more profit efficient than those reviewed in literature review. Despite that, inefficiency exist in the utilization of resources since the mean, maximum and minimum levels of profit efficiencies obtained from the study were 0.8823, 1.000 and 0.0201 respectively. The determinant of profit efficiency such as cost of hired labour (-0.985), cost of seed (-0.556), fertilizer cost (-3.968), cost of herbicide (-2.432), capital (-0.297) were negative and significant (P<0.01) and only farm land (-0.340) were negative and non-significance. Also, the findings of the inefficiency model revealed that coefficient of education (-0.245) Extension service (-0.485), access to credit (-1.874), farming experience (-0.189), variety variable (-0.791), membership Association (-0.189), (0.579), household size (-0.950) and distance to the market (-2.162) were found to reduce profit inefficiency while Off- farm income (0.131) and access to market information were found to increased profit inefficiency as seen in some of the literature review. The following recommendations were made:

1. Government and policy makers should ensure that the right legislation is put in place so as to enable sesame farmers get this inputs at subsidized rate and also at the right time. Also, government land should be opened up to practicing sesame farmers.
2. Government should ensure that extension workers are well equipped with the right techniques and training in sesame production for onward dissemination to the farmers.
3. Farmers should be encourage to form well managed and organized cooperatives or producer farmer groups and networks to give the farmers access to inputs, output markets, as well as credit facilities on timely basis to invest in sesame farming
4. Experienced farmers should be encouraged to share their experiences with prospective entrants, extend better teaching and learning opportunities to the farmers.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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